Consumption of aquatic products and meats in Chinese residents: A cross-sectional study in 2014

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Abstract

Objective

To characterize the distribution, potential determinants of the consumption of aquatic products and meats, as well as part of the nutritional behavior of Chinese residents in a nationwide representative sample.

Methods

The study was conducted using a multi-stage stratified random cluster sampling technique and a population-proportional sampling procedure in 14 provinces in China. Chinese subjects aged 3 years and above (n = 24,106) completed a face-to-face dietary interview from July to October in 2014.

Results

The average daily consumption of meat and aquatic products for the all-aged population was 70.9 g and 48.0 g, respectively, which aligned with Dietary Guidelines (40-75g/d) for Chinese Residents (2016). Intake of aquatic products among Chinese people was relatively insufficient, especially for adolescents and elder people (<40g/d). Males, mainly aged 19-60, generally consumed too much meat (>80g/d), and 19-44 grouping consumed more than 70g/d of red meat. Besides, urban residents and individuals with higher SES have exhibited more comprehensive dietary preferences than rural ones and those with a lower SES do. Women and the higher SES group tend to be closer to the dietary guidelines for the Chinese.

Conclusions

The consumption of meat and aquatic products varied with age, sex, region and SES. Detecting patterns in consumption is particularly relevant for policy makers, researchers and health professionals in the formulation of dietary recommendations and estimating potential health outcomes.

1. Introduction

Healthful dietary patterns have long been shown to reduce the risk of diet-related chronic diseases and benefit health throughout all stages of life(1–4). Over the past decades,rapid economic development has introduced remarkable changes in diet patterns in China. A considerable increase has been observed in the demand for meats and aquatic products. A growing body of research worldwide has examined the consumption pattern of these two food categories and its association with diet-related health and diseases(5–7). Previous research has demonstrated that high intake of red meat, especially processed meat, is related to increased risk of hyperlipidemia, hypertension, osteoporosis, stroke, cancer, and all-cause deaths(8–14). Comparatively, white meats (such as poultry and aquatic products), which contains high-quality protein and a wide range of essential micronutrients with relatively lower saturated fats and cholesterol, is considered as a healthier choice(15).

Indeed, present dietary recommendations for the prevention of diet-related chronic diseases have promoted lower intake of red and processed meat and higher intake of plant-based foods. And countries worldwide have introduced dietary guidelines for their residents. The latest Guidelines for Australian Adults advise people to limit their intake of foods containing saturated fat(16). While the 2015–2020 Dietary Guidelines for Americans recommended the consumption of a variety of protein foods, including seafood, lean meats, and poultry(17). China also introduced a new version of the Dietary Guidelines for Chinese Residents (DGC) in the form of the Chinese Food Pagoda in 2016, intending to help residents adopt healthful lifestyles and improve fitness(18).

Whether the intake of foods conforms to the Dietary Guidelines is important to health. In China, although the China's national bureau of statistics (NBS) collects annual statistics on the food consumption of residents, the information of the distribution of food consumption among different groups of people (demography or sociology) is excluded. Obviously, people with different gender, age, region and socioeconomic status (SES) have different levels of food consumption. This presents a gap in knowledge that which groups would eat more red meat, or which populations may have healthier meat consumption patterns.

The study was conducted to assess the consumption of aquatic products and meats among the general population in China, and to further explore the difference in dietary behavior among different gender, age, regions and SES groups. Our study may shed light on different consumption patterns of different groups, and provide forewarning of future epidemics and their causes. And, this could contribute to our understanding of the diet patterns in China that would guide further scientific research and policy-making.

2. Methods

2.1 Study design and participants

We examined data from The Chinese Food Consumption Survey (CFCS) in 2014. The CFCS was a cross-sectional national survey conducted in China during July to October 2014. The participants were aged ≥ 3, Chinese-speaking, and living in private households. This survey was a collaborative project among the China National Center for Food Safety Risk Assessment (NFSA), the Chinese Center for Disease Control and Prevention (CDC), and Community Services Centers. The survey was designed to collect information on individuals' consumption of alcohol, beverages, meats, aquatic products, and processed foods, as well as health behavior, and to further examine how potential risk factors affect people's health.

The sample was collected using a multistage stratified random sampling procedure and a population-proportional sampling (PPS) technique in 14 provinces, autonomous regions, and municipalities in China, covering Hebei, Inner Mongolia autonomous region, Liaoning, Heilongjiang, Jiangsu, Zhejiang, Jiangxi, Shandong, Hubei, Guangdong, Chongqing, Guizhou, Yunnan, and Gansu. Thirty-one sites were selected randomly from cities or counties in the above

provinces. Three towns/streets in each survey site, two villages/communities in each town/street, and fifty households in each village/community were selected. Each survey site included at least 300 households and 900 respondents. Inhabitants aged 3 years and older who had lived in the neighborhood for at least 6 months were identified. 24,106 participants were recruited to the study. The response rate was above 85%.

2.2 Data collection

Household conditions (family population, annual per capita income) and individual demographics (age, nationality, marital status, education, and occupation), were obtained using a self-reported questionnaire. Trained staff then conducted a face-to-face interview using a standard questionnaire at the home of the participants. Dietary assessment survey was based on a combination of data collected using a validated food frequency questionnaire (FFQ) and a self-reported, 3-day, 24-hour recall at the individual level. i) The 3-day, 24-hour retrospective survey method, aimed to estimate individual food consumption based on the weight of food purchased and the percentage of that day's consumption within 24 hours of the survey date. Considering daily variations in food intake, the participants were interviewed on two consecutive weekdays and one weekend day. The investigation of aquatic food items mainly concerned fish, crustaceans, mollusks, and alga; while that of meat items included livestock and poultry. ii) The consumption frequency survey covered fresh and processed aquatic products, animal offal, traditional Chinese processed meats, and hand-made and industrially processed meat products over the last 12 months.

All respondents aged 3 and older with reliable dietary data were included and appropriate weighting factors were applied to adjust for differential probabilities of selection and non-response. Household food consumption data were used to estimate the consumption of meat and aquatic products. All participants were fully informed in detail about the objective and the procedure before enrolling in the study and signed a written consent form. For children younger than 12 years, parents or primary caregivers were asked to recall the children's food consumption and signed informed consent on behalf of their children. All minors (below the age of 18) were investigated with the informed consent of their parents or guardians (parent or legal guardian consent was obtained on behalf of all minors). The surveys were approved by the Ethical Review Committee of China National Center for Food Safety Risk Assessment.

2.3 Categorization of Meats and Aquatic products

"Fish" refers to fresh-water fish and sea-fish. "Crustaceans" refers to shrimp and crabs. "Mollusks" refers to shellfish, snails etc. "Livestock meat" mainly refers to pork, beef, and mutton, which includes muscle meat only, not offal. "Poultry" refers to chickens, ducks, and other poultry. "Processed meat" includes sausages, bacon, ham, nuggets, salami, and other fermented meats. "Aquatic processed products" refers to smoked, pickled, and industrially processed products. All organ and offal meat were reported together because of the low frequency of consumption at the population level. "Traditional Chinese processed meats" refers to smoked, soy sauce, and pot-stewed meat. "Hand-made and industrially processed meat products" refers to cured meat, sausages, pork floss, canned meat, etc.

2.4 Statistical analysis

We categorized the subjects into five age groups: 3–18, 19–30, 31–45, 46–60, and ≥ 61 years, and also performed further analyses stratified by gender. To describe the social status of the participants, a social class-index (SEI) was introduced based on the monthly income of the household, education level and the employment status of the principal earner in the household to evaluate the SES of Chinese residents(19).

Description of the residents' aquatic products and meats consumption by age and gender was presented as an arithmetic mean and 95% confidence interval (CI). Pairwise comparisons of the means across groups were tested using one-way classification analysis of variance (ANOVA), and a post hoc multiple comparison was performed using a least significant difference-t test. A level of $\alpha < 0.05$ was considered statistically significant and all statistical significance tests were two-sided. All analyses were completed using Stata version 13.0 (StataCorp, College Station, TX, USA).

3. Results

The demographical characteristics of the sample is consistent with that of official national statistics in China (Statistical Bulletin of the National Economic and Social Development of the People's Republic of China in 2017). Among the 24,106 participants who completed the diet history interview, 11,986 were men (49.7%) and 12,120 were women (50.3%). The mean age was 40.2 years for men and 40.7 years for women. When computing SES, 7,096 subjects were excluded because of missing information, including those with no income and those who were students, attending preschools, and "other". 17,010 participants were included in the regression model, among whom 8,176 (48.1%) were male and 8,834 (51.9%) were female. The characteristics of the participants are shown in Table 1.

Table 1
Characteristics of the participants in the diet history interview in 2014(n = 24,106)

	Men(n = 11,986)	Women(n = 12,120)
Age group (%)		
3–18	2127(17.7%)	1920(15.8%)
19–30	1517(12.7%)	1635(13.5%)
31–44	2954(24.6%)	2957(24.4%)
45–59	3442(28.7%)	3657(30.2%)
≥ 60	1946(16.2%)	1951(16.1%)
Area		
Urban	4257(35.5%)	4649(38.4%)
Rural	7729(64.5%)	7471(61.6%)
Career		
Student	1567(13.1%)	1438(11.9%)
Housework	670(5.6%)	2649(21.9%)
Unemployed	383(3.2%)	401(3.3%)
Retired	941(7.9%)	970(8.0%)
Government	416(3.5%)	268(2.2%)
Technician	1157(9.7%)	753(6.2%)
Administrator	478(4.0%)	570(4.7%)
Service staff	1112(9.3%)	1209(10.0%)
Producer	2787(23.3%)	2270(18.7%)
Operator	606(5.1%)	138(1.1%)
Soldier	20(0.2%)	3(0.0%)
Preschooler	621(5.2%)	547(4.5%)
Other	1228(10.2%)	904(7.5%)
School education		
No schooling[a]	632(5.3%)	557(4.6%)
Illiteracy	243(2.0%)	824(6.8%)
Primary school	2847(23.8%)	3166(26.1%)
Junior school	4399(36.7%)	4095(33.8%)
High school	2292(19.1%)	2016(16.6%)
Junior College	845(7.0%)	802(6.6%)
University & above	728(6.1%)	660(5.4%)
Household income(□)		
None applicable	585(4.9%)	591(4.9%)
≤ 4999	1636(13.6%)	1742(14.4%)
5000–9999	2087(17.4%)	2081(17.2%)
10000–14999	2331(19.4%)	2305(19.0%)
15000–19999	1421(11.9%)	1424(11.7%)
20000–24999	1190(9.9%)	1208(10.0%)
25000–29999	750(6.3%)	772(6.4%)

[a] No schooling means children who have not reached school age.

	Men(n = 11,986)	Women(n = 12,120)
30000–34999	715(6.0%)	705(5.8%)
35000–39999	356(3.0%)	359(3.0%)
≥ 40000	915(7.6%)	933(7.7%)
SES (%)	n = 8176	n = 8834
Low	3788(46.3%)	3378(38.2%)
Medium	2486(30.4%)	3983(45.1%)
High	1902(23.3%)	1473(16.7%)

[a] No schooling means children who have not reached school age.

3.1 Consumption of aquatic products and meats

In general, the consumption of meat per day was 70.9 g/d (95%CI: 70.0, 71.7) and that of aquatic products was 48.0 g/d (95% CI: 47.2, 48.8).

Consumption of aquatic products is presented in Table 2. The participants mainly consumed fish (70–80%), followed by crustaceans (15–20%). The consumption of other aquatic products was somewhat low. Younger adults and middle-aged groups (19–60 years) presented a higher level of consumption of aquatic products compared to older adults. The 31–44 age group consumed the highest amount (55.7 g/d) of total aquatic products. Children and adolescents (3–18 years) consumed the least amount (32.1 g/d). The difference of consumption between men and women was 7.6 g/d.

Table 2

Daily aquatic products consumption by gender and age groups using 24 h recalls (g/d) *

Group Gender		3–18 years	19–30 years	31–44 years	45–59 years	60–99 years	Average
		Mean(95%CI)	Mean(95%CI)	Mean(95%CI)	Mean(95%CI)	Mean(95%CI)	Mean(95%CI)
Alga	Males	0.129(0.059,0.198)	0.134(0.062,0.205)	0.191(0.108,0.274)	0.255(0.170,0.340)	0.224(0.127,0.322)	0.196(0.158,0.23
	Females	0.121(0.061,0.181)	0.211(0.114,0.307)	0.309(0.162,0.456)	0.204(0.139,0.268)	0.191(0.108,0.274)	0.215(0.169,0.26
Crustaceans	Males	7.21(6.27,8.15)	10.3(8.75,11.8)	12.6(11.4,13.8)	9.80(8.90,10.7)	7.61(6.51,8.71)	9.73(9.23,10.2)
	Females	6.94(5.96,7.92)	9.18(7.88,10.5)	11.5(10.3,12.8)	7.97(7.22,8.72)	6.51(5.48,7.54)	8.61(8.14,9.08)
Fish	Males	24.9(23.2,26.6)	40.3(37.6,43.0)	44.2(42.1,46.3)	44.9(43.0,46.8)	38.2(35.9,40.5)	39.5(38.5,40.5)
	Females	21.7(20.0,23.3)	36.4(33.5,39.2)	36.9(35.1,38.7)	37.0(35.4,38.7)	30.8(28.9,32.8)	33.5(32.6,34.3)
Mollusks	Males	1.56(1.12,2.00)	2.23(1.63,2.83)	3.06(2.58,3.54)	2.37(1.99,2.75)	2.28(1.77,2.78)	2.36(2.15,2.57)
	Females	1.48(1.16,1.79)	1.62(1.23,2.02)	2.63(2.24,3.01)	2.03(1.71,2.35)	1.48(1.14,1.83)	1.95(1.78,2.11)
Total	Males	33.8(31.6,35.9)	52.9(49.3,56.4)	60.1(57.3,62.8)	57.3(54.9,59.8)	48.3(45.3,51.2)	51.8(50.6,53.0)
	Females	30.2(28.1,32.3)	47.4(43.9,50.8)	51.3(48.9,53.8)	47.3(45.2,49.3)	39.0(36.5,41.5)	44.2(43.1,45.3)
Total		32.1(30.6,33.6)	50.0(47.5,52.5)	55.7(53.9,57.5)	52.1(50.5,53.7)	43.6(41.7,45.6)	48.0(47.2,48.8)

*Keeping three valid digits

The consumption of meat and meat products for the participants is shown in Table 3. Pork was the most consumed category, which constitutes 2/3 of the total consumption, followed by poultry (about one fifth); beef and mutton were the least consumed. Meat consumption varied by age and gender. Children, adolescents, and the elderly over 60 years old consumed about 60 grams meat per day, whereas younger adults and middle-aged people consumed more than 75 g/d meat per day on average. Males had higher consumption of meat than females with a difference of 13.3 g/d, and the certain difference could be mainly detected in red meat.

Table 3
Daily meat consumption by gender and age groups using 24 hours recalls (g/d) *

Group Gender		3–18 years	19–30 years	31–44 years	45–60 years	61–99 years	Average
		Mean(95%CI)	Mean(95%CI)	Mean(95%CI)	Mean(95%CI)	Mean(95%CI)	Mean(95%CI)
Beef	Males	4.63(3.86,5.39)	7.59(6.40,8.77)	6.80(6.08,7.52)	5.55(4.92,6.19)	2.91(2.37,3.46)	5.53(5.19,5.86)
	Females	2.87(2.34,3.41)	5.43(4.53,6.33)	5.04(4.46,5.63)	4.10(3.56,4.64)	2.42(1.95,2.89)	4.05(3.77,4.32)
Mutton	Males	2.70(1.98,3.42)	5.09(3.96,6.23)	3.92(3.23,4.62)	4.10(3.41,4.80)	2.28(1.71,2.84)	3.64(3.30,3.98)
	Females	2.15(1.59,2.71)	2.84(2.17,3.50)	3.01(2.44,3.58)	2.75(2.27,3.23)	1.37(1.00,1.73)	2.51(2.26,2.75)
Pork	Males	42.0(40.3,43.7)	56.5(54.0,59.1)	60.3(58.3,62.3)	56.0(54.4,57.6)	48.1(46.1,50.0)	53.3(52.5,54.2)
	Females	40.2(36.4,43.9)	46.4(44.2,48.6)	48.3(46.8,49.8)	46.4(45.0,47.7)	41.0(39.4,42.7)	45.0(44.1,45.9)
Poultry	Males	13.9(12.7,15.2)	15.7(14.1,17.2)	17.2(16.0,18.4)	15.3(14.2,16.3)	11.2(10.2,12.3)	14.9(14.4,15.5)
	Females	11.7(10.6,12.9)	15.0(13.6,16.5)	14.4(13.3,15.4)	12.1(11.3,12.9)	9.14(8.20,10.1)	12.5(12.0,13.0)
The total	Males	63.2(60.5,66.0)	84.9(80.9,88.9)	88.3(85.3,91.3)	80.9(78.4,83.5)	64.5(61.6,67.3)	77.4(76.1,78.8)
	Females	56.9(52.7,61.2)	69.7(66.3,73.0)	70.7(68.3,73.1)	65.3(63.3,67.4)	53.9(51.5,56.4)	64.1(62.8,65.3)
The total		60.2(57.8,62.7)	77.0(74.4,79.6)	79.5(77.6,81.4)	72.9(71.2,74.5)	59.2(57.3,61.1)	70.9(70.0,71.7)

*Keeping three valid digits

Table 4 presents the consumption pattern of aquatic products and meat products. On average, participants consumed fish almost twice a week, while they consumed crustaceans and alga no more than once a week. Additionally, participants had relatively low frequencies of the consumption for mollusks and processed aquatic products, with an average of nearly once a month. In terms of meat products, the participants consumed processed meat (excluding barbecued meat) at a frequency of 3 times per month, with a daily mean consumption of 7.3–9.4 g/day. Comparatively, the participants were less likely to consume animal offal, with an average frequency of lower than once a month. In general, the consumption frequency of barbecued meat was low.

Table 4
Consumption pattern of aquatic products and meat products over the last 12 months*

Food Groups	Daily consumption (g)	Frequency/week
Aquatic products		
Alga	1.27(1.23,1.32)	0.544(0.531,0.557)
Crustaceans	7.35(7.10,7.59)	0.757(0.738,0.776)
Fish	29.2(28.4,29.9)	1.95(1.92,1.99)
Mollusks	2.16(2.07,2.26)	0.229(0.221,0.236)
Processed#1	3.04(2.91,3.17)	0.355(0.344,0.367)
Meat products		Frequency/month
Barbecue	1.00(0.923,1.08)	0.262(0.245,0.279)
Animal offal	1.77(1.62,1.92)	0.782(0.755,0.809)
Processed meats#1	7.28(6.97,7.59)	3.15(3.12,3.18)
Traditional meats#2	9.40(9.09,9.72)	3.13(3.09,3.18)

*Keeping three valid digits

#1Hand-made and industrial processed meat and aquatic products

#2Traditional Chinese processing meats

3.2 Difference in consumption by region and gender grouping

As is shown in Table 5, the average intake of aquatic products and meats were 56.8 g/d and 79.0 g/d respectively for urban residents, and 42.8 g/d and 65.8 g/d respectively for rural residents. Urban residents consumed more aquatic products and meats than rural residents did. The difference of the

consumption on crustaceans, beef, and mutton was much higher (the difference was two to five times, in same gender). And, there was only a slight difference in the consumption of fish and poultry, and almost no difference in that of pork.

Table 5

Daily consumption of aquatic products and meats by gender and region using 24 h recalls (g/d)*

	Urban		Rural	
	Males	Females	Males	Females
Aquatic products				
Alga	0.210(0.140,0.281)	0.235(0.139,0.330)	0.189(0.143,0.235)	0.203(0.158,0.248)
Crustaceans	16.1(15.0,17.2)	13.9(12.9,14.8)	6.23(5.78,6.68)	5.34(4.89,5.79)
Fish	43.1(41.4,44.8)	35.4(34.0,36.8)	37.5(36.4,38.7)	32.3(31.2,33.4)
Mollusks	2.95(2.52,3.38)	2.30(2.00,2.60)	2.04(1.81,2.26)	0.892(0.745,1.04)
The total1	62.4(60.0,64.7)	51.8(49.9,53.7)	46.0(44.5,47.4)	39.5(38.2,40.9)
The total2	56.8(55.3,58.3)		42.8(41.8,43.8)	
Meats				
Beef	10.4(9.63,11.2)	7.48(6.88,8.09)	2.83(2.55,3.11)	1.91(1.69,2.12)
Mutton	8.08(7.22,8.94)	5.11(4.52,5.69)	1.19(0.980,1.41)	2.03(1.71,2.35)
pork	52.0(50.6,53.5)	44.4(42.5,46.2)	54.1(53.0,55.2)	45.4(44.5,46.3)
poultry	17.1(16.1,18.2)	14.1(13.3,15.0)	13.7(13.1,14.3)	11.5(10.9,12.1)
The total1	87.7(85.3,90.0)	71.1(68.7,73.4)	71.8(70.2,73.4)	59.7(58.3,61.1)
The total2	79.0(77.3,80.7)		65.8(64.8,66.9)	

*Keeping three valid digits

3.3 Difference in consumption by socio-economic status and gender grouping

As is shown in Table 6, participants with higher SES generally consumed more meats and aquatic products than those with lower SES. However, there was no distinct difference in the consumption of alga and mollusks because of their low intake in general. The average intake of aquatic products for females with a low SES was lower than 40 g/d; fish consumption alone was 10 g/d less than that of people of other genders and classes. Males with high SES consumed meat more than 90 g/d, including more high-quality protein meats. Besides, women's consumption of meat lower than that of men's was mainly because of less consumption pork.

Table 6

Consumption of aquatic products and meats by gender and socioeconomic status (SES) grouping*

Foods	Sex	SES					Pairwise comparisons
		Low(A)	Median(B)	High(C)	F	P	
		Mean(95%CI)	Mean(95%CI)	Mean(95%CI)			
Aquatic products	Males	51.6(49.4,53.8)	52.5(49.8,55.3)	63.3(59.9,63.7)	18.4	< 0.001	C > B = A
	Females	37.3(35.5,39.2)	50.3(48.2,52.3)	57.8(53.8,61.8)	66.8	< 0.001	C > B > A
Alga	Males	0.203(0.133,0.274)	0.235(0.144,0.327)	0.177(0.090,0.263)	0.391	0.675	NS#
	Females	0.253(0.130,0.375)	0.259(0.181,0.336)	0.232(0.136,0.327)	0.052	0.954	NS#
Crustaceans	Males	8.63(7.83,9.44)	10.0(8.86,11.2)	13.4(11.9,14.8)	17.7	< 0.001	C > B > A
	Females	6.45(5.61,7.30)	9.33(8.54,10.1)	14.4(12.6,16.3)	43.6	< 0.001	C > B > A
Fish	Males	40.0(38.2,41.8)	40.2(38.1,42.3)	46.9(44.4,49.4)	11.3	< 0.001	C > B = A
	Females	28.5(27.1,29.9)	38.9(37.3,40.6)	40.3(37.2,43.4)	49.8	< 0.001	C = B > A
Mollusks	Males	2.75(2.37,3.14)	2.06(1.63,2.48)	2.80(2.18,3.41)	2.98	0.051	NS#
	Females	2.16(1.84,2.48)	1.74(1.48,2.01)	2.84(2.20,3.48)	7.06	< 0.001	C > B,B = A
Meats	Males	69.8(67.5,72.1)	78.3(75.4,81.3)	94.6(90.8,98.4)	63.8	< 0.001	C > B > A
	Females	57.7(55.7,59.8)	63.3(59.9,66.7)	83.1(79.3,86.8)	86.2	< 0.001	C > B > A
Beef	Males	2.82(2.43,3.21)	5.52(4.56,5.93)	10.0(8.84,11.2)	103	< 0.001	C > B > A
	Females	2.47(2.05,2.90)	3.24(2.81,3.67)	9.58(8.38,10.8)	117	< 0.001	C > B > A
Mutton	Males	2.44(1.94,2.94)	2.85(2.25,3.44)	6.38(5.19,7.57)	30.4	< 0.001	C > B = A
	Females	1.56(1.16,1.97)	1.70(1.38,2.02)	5.56(4.52,6.60)	54.8	< 0.001	C > B = A
Pork	Males	52.1(50.5,53.7)	55.9(54.0,57.8)	60.1(57.7,62.4)	16.0	< 0.001	C > B > A
	Females	42.9(41.5,44.2)	45.2(43.9,46.4)	51.7(49.3,54.1)	23.9	< 0.001	C > B > A
Poultry	Males	12.4(11.6,13.2)	14.3(13.2,15.5)	18.2(16.6,19.7)	24.5	< 0.001	C > B > A
	Females	10.8(10.0,11.7)	11.7(10.9,12.5)	16.2(14.7,17.8)	23.0	< 0.001	C > B = A

*Keeping three valid digits

#NS = not significant.

4. Discussion

Monitoring a population's dietary intake is important to identify patterns of food and nutrient intake. The survey showed that the average daily consumption of all meats was 70.9 g/d across all-aged populations, which aligned with the daily recommended intake of 40–75 g/d by the DGC (2016)(18). However, the consumption of male people aged 19–60 was generally over recommended (> 80 g/d). The national bureau of statistics reported that the average meat intake increased from 69.9 g/d in 2000 to 102.7 g/d in 2014 for urban residents, and from 50.1 g/d to 80 g/d for rural residents(20). By contrast, our study reported 79.0 g/d and 65.8 g/d for urban and rural respondents in 2014, respectively. The reason might be that our sample included younger and elder age groups whose consumption was lower, and covered different geographic regions.

Red meats like beef, pork, and lamb are rich in protein, energy, fat, and trans-fatty acid (TFA)(21). The World Cancer Research Fund advocates reducing the intake of red meat to less than 70 grams per day, or 500 g per week (cooked weight)(22), and avoiding processed meats such as ham, bacon, salami, hot dogs, and sausages(23). We found that males aged 19–44 generally consumed more than 70 g/d of red meat. Thus, younger and middle-aged males should be wary of exceeding the recommended limit. Besides, our study showed that the mean daily consumption of processed meat products was about 17.7 g/d (including barbecued meat). This estimate should be higher due to the presence of the recall bias, however. Previous research have demonstrated that an intake of 50 g/d of processed meats would increase the risk of cancer, diabetes, coronary heart disease, stroke(24–27), and even all-cause mortality(28). As the estimator was not meeting the standard requirements, it is imperative to reduce the consumption of processed meat as possible. In general, the western population eat more meat than the Chinese population; A German study revealed that adult men consumed 105 grams of meat products per day and women consumed 64 grams per day in 2006(29). In UK, the mean daily consumption of meat products was more than 1.5 times higher than that in Germany(30). In our study, adult men consumed 80.7 grams per day and women consumed 65.5 grams per day. The higher absolute consumption of western males in meat and meat products is comparable to that of the westerner dietary pattern(31, 32). However, the difference for females is much smaller.

There is a general consensus that aquatic foods are healthier than those of red meats(33–36), such as low in saturated fats and cholesterol. It was found that the mean daily consumption of aquatic products was 48.0 g, which barely meet the recommendation according to the DGC. Importantly, intake among elder

people and children was insufficient (< 40 g/d). The Germany food consumption survey indicated that adult men consumed 28 g/d of aquatic products and women consumed 22 g/d(29). In our study, men consumed 51.8 g/d and women consumed 44.2 g/d, which almost doubled the amount consumed by the German cohort. Considering that fish is a healthier substitute for red meat, we believe that there still need room to promote intake of fish among Chinese residents, especially for adolescents and the old. In addition, our research showed that females consumed less red meat than males did, while they ate similar quantities of white meat. Therefore, women in China appeared to make wiser food choices, and this conclusion is consistent with the German study(29).

As for the association with region and socio-economic status for aquatic and meat products consumption, urban residents and people with a higher SES consumed more meat and aquatic products than did rural residents and those with a lower SES, and they mostly consumed much more beef, and mutton, and more white meat such as crustaceans and poultry. Therefore, socio-economic status and demographic factors might be key drivers of dietary choices. Although males with a higher SES and income generally consumed more red meat (more than 70 g/d) in our study, people of this class exhibited some more comprehensive dietary preferences(37). Similar patterns regarding SES and dietary behavior were also observed in European studies. A study from Dutch National Food Consumption Surveys suggested that dietary intake among subjects with higher SES tended to be closer to the guidelines of the Netherlands Food and Nutrition Council, and the findings was relatively stable throughout the decades assessed in the study(38). The results suggested that with increasing economic income, improved education levels, and increased recognition, the pursuit of a healthy lifestyle has become more popular(39).

One strength of our study is the large and rigorously selected population sample of 24,106 participants which is representative of the general Chinese population. In addition, we employed three recognized factors to further examine the relationship between SES and food consumption. Furthermore, there was no evidence of serious non-response bias, although dietary surveys inevitably favor willing participants whose diets may be extreme, or variable across days. Our consumption data were primarily based on 3-day, 24-h food recall, and therefore may not represent long-term dietary habits. However, at the national level, our study still provides a reliable assessment of the consumption of meats and aquatic products, and is important for international comparisons and investigation of the changes over time.

Some limitations of the present study should be considered. First, recall bias was inevitable because of the use of a diet history interview and its questionable reliability(40). Second, under-reporting, a common limitation based on history dietary assessment, could lead to measurement bias. The tendency for respondents to misreport the consumption of socially undesirable food choices has been identified in several studies in European countries(41–43).

In conclusion, the present study revealed the pattern of meats and aquatic products consumption in a nationally representative sample of the Chinese population. Differences in consumption among different population groups (sex, age, region and SES) were reported. Understanding the trends and determinants of dietary intake could guide our efforts to reduce the burden of chronic diseases in China. Further research based on dynamic dietary patterns, with the aim of reducing the consumption of animal foods and promoting the consumption of more aquatic products, may help identify healthy food patterns for the general population.

Abbreviations

Dietary Guidelines for Chinese Residents (DGC); China's national bureau of statistics (NBS); socioeconomic status (SES); Chinese Food Consumption Survey (CFCS); China National Center for Food Safety Risk Assessment (NFSA); Chinese Center for Disease Control and Prevention (CDC); population-proportional sampling (PPS); food frequency questionnaire (FFQ); social class-index (SEI); confidence interval (CI); one-way classification analysis of variance (ANOVA); trans-fatty acid (TFA);

Declarations

Ethical Approval and Consent to participate

All participants provided written informed consent. All minors (below the age of 18) were investigated with the informed consent of their parents or guardians (parent or legal guardian consent was obtained on behalf of all minors). The study protocol was reviewed and approved by the Ethics Committee of the China Center for Disease Control and Prevention.

Consent for publication

All participants provided written informed consent.

Availability of data and material

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests

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Not applicable.

Authors' contributions

Liying Jiang drafted the protocol and contributed to interpretation of results. Junjie Shen wrote the final paper. Jianwen Li, Sana Liu, Yujie Liu, Huijun Wang and Chang Su participated in the data collection. Aidong Liu have reviewed the draft and Xun Zhuang have made critical revisions. All authors have reviewed final manuscript and approved it for publication.

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- 24hconsumption.txt
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- aquaticproductsconsumptionfrequency.txt